IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Kitson et al.
Serial No:	09/816,942
For:	BISTABLE NEMATIC LIQUID CRYSTAL DEVICE
Filed:	March 23, 2001
Examiner:	Thoi V. Duong
Art Unit:	2871

Customer No.: 27623
Attorney Docket No.: 30001063-2

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DECLARATION UNDER 37 C.F.R.§ 1.132

I, Stephen Christopher Kitson, a citizen of the United Kingdom and a resident of 10 Stoney Stile Road, Alveston, Bristol, declare as follows.

1. I was awarded a first class honours degree in physics from the University of Exeter, UK, in 1991 and a PhD in physics also from the University of Exeter in 1995.

2. I am currently a research scientist with Hewlett-Packard Limited, a position I have held since 17th August 1998. Since that time I have worked extensively in the area of liquid crystal display research and development, focusing in particular on the alignment of nematic liquid crystal materials on microstructured surfaces. In my previous positions (research scientist at the Defence Evaluation and Research Agency, UK, 1996 – 1998, and as a post-doctoral research assistant at Exeter University, 1994 – 1996) I worked on different aspects of microstructured surfaces, in particular the novel optical properties of sub-wavelength structures.

3. I have revisited the specification and claims of US Patent Application No. 09/816,942 (the present application) for which I am named as an inventor, and the citations and rejections raised in the Office Action ("Action") dated May 21, 2003 and am now familiar with their contents.

4. The present invention relates to a bistable nematic liquid crystal device in which the bistability is provided by a surface alignment comprising an array of posts on the inner surface of at least one of the cell walls. The shape and/or orientation of the posts is selected to induce the liquid crystal director adjacent the posts to adopt two different tilt angles in substantially the same azimuthal direction. The liquid crystal director can be bistably switched between the two tilt angles by the application of suitable electric fields, as described in the present application.

5. In my opinion, none of the prior art of record discloses or suggests the present invention as defined in the claims presently on file. My comments on each of the prior art documents cited in the outstanding Office Action (mailed on 21 May 2003) are set forth below.

Bryan-Brown *et al* (US 6,456,348 B2)

6. Bryan-Brown describes a bistable nematic LCD in which the bistability is provided by an asymmetric monograting with its groove height to width selected to give approximately equal energy within the nematic material in two allowed alignment arrangements. This type of display is now often referred to as a zenithal bistable nematic display ("ZBN" or "ZBD"). In all of the three examples described by Bryan-Brown, the grooves of the monograting are coated with a surfactant to obtain homeotropic anchoring, and it is now known that such homeotropic anchoring is necessary for operation of the display. See, for example, *Reflective Liquid Crystal Displays* by Wu & Yang, 2001, pp 261-263 (extract attached). The extract includes a schematic diagram of the liquid crystal director configurations of the two bistable states, in each of which the LC director is homeotropic to the local surface of the monograting.

7. The Action states that Bryan-Brown "discloses that both cell walls are embossed with small pillars (of 1-3 micrometers height and 5-50 micrometers or more width) in the inner surfaces to provide a grating..."This is not correct. First of all, Bryan-Brown does not describe any actual experimental result involving the spacer pillars. These structures are absent from all of the examples for which results are given by Bryan-Brown. Bistability is therefore achieved in the absence of any spacer pillars, as described by Bryan-Brown and the Wu & Yang book extract. What Bryan-Brown does do is to mention the possibility that, in addition to the grating, small spacer pillars could be provided by means of the embossing. These theoretical small spacer pillars are said to be "for assisting in correct spacing apart of the cell walls and also for a barrier to liquid crystal flow when the cell is flexed". Secondly, the Action is erroneous when it states that the (theoretical) spacer pillars "provide a grating". Clearly they do not provide a grating; they are additional to the grating since the grating already exists in the form of grooves, and Bryan-Brown explicitly says so.

8. The above conclusion is also evident from a consideration of what a grating is. A "grating" is a surface with an array of parallel grooves; it is not an array of "pillars". The spacer pillars are different from the grating and they perform totally different functions from the grating. Bryan-Brown specifically talks about the surface having grooves, for example in column 3, lines 36-37 the "grating may have a symmetric or asymmetric groove profile". In the following section, column 3 lines 38-45, Bryan-Brown further defines what is meant by a groove profile by providing equation (1). From this equation it is clear that the surface profile only depends on x – ie, it is an array of 1D grooves, not posts or pillars, as suggested by the Action. There are many other instances where the grating surface is described as having grooves. It is my opinion that Bryan-Brown teaches that the spacer pillars will not provide a bistable display because, if they did, the grating would not be needed. Since the grating or grooves are essential to the teaching of the Bryan-Brown reference, to suggest that the support pillars would effect a bistable display would be a case of hindsight reconstruction and contrary to the actual purpose of the pillars, i.e., to set the spacing.. It is my opinion that the spacer pillars set forth in the Bryan-Brown reference would, in fact, not effect a bistable display by effecting alignment as erroneously suggested by the Action.

9. The Action appears to state that the (theoretical) spacer pillars will inevitably result in a bistable liquid crystal device according to the present invention because of the quoted height range for the spacer pillars and their proposed formation from the same material as the alignment layers. This is not so. As discussed in the present application at page 7, line 35 to page 8, line 3 "if the posts are too low, planar orientation will tend to predominate, whilst if the posts are too high, a high tilt or homeotropic orientation will predominate." What is too low or too high for a particular device will depend on the cell spacing and the nature of the LC material. However, a spacer pillar which spans the entire cell gap is in my opinion likely to be too high, thus causing high tilt or homeotropic orientation. The provision of such spacer pillars is contemplated in the present application at page 8, lines 13-14, i.e., "The alignment posts may optionally be interspersed with taller posts for providing cell spacing". The term "alignment posts" is used here to distinguish posts which give bistable alignment from taller posts which could be provided to space the cell walls apart. As for theoretical pillars for "a barrier to liquid crystal material flow when the cell is flexed" one can only speculate about any alignment effect in the absence of experimental results. However, in my opinion there is no reason why such structures would necessarily induce bistable alignment rather than a planar or other monostable alignment, even if the spacer pillars are formed by the material of the alignment layers. .

10. Rather than hypothesising about the properties of theoretical pillars, it is instructive to consider what one of the inventors, G. P. Bryan-Brown, has to say about actual spacer pillars. See, for example: Proceedings of 20th International Displays Research Conference, Palm Beach, Florida, USA (September 2000) pp

229 – 232 (copy attached). This paper describes a ZBD device in which one of the cell walls is provided with pillars to aid spacing apart of the cell walls. In the final paragraph on page 230, the author says "Observation of the cell during switching showed that the pillars did not affect the stability of either state and do not significantly modify the switching in the region around the pillars. This is in contrast to other bistable LCDs where spacer pillars have been known to seed defects and compromise long term bistability." The only reasonable conclusion which one may reach from this paper is that the pillars described in Bryan-Brown, at best, do not affect the bistability which is induced by the grating; at worst, spacer pillars compromise bistability. They do not of themselves confer bistability on a nematic liquid crystal display, even if formed of the same material as the alignment layers.

11. It is my opinion that Bryan-Brown does not disclose or suggest a surface alignment comprising an array of posts, let alone an array of posts which have at least one of a shape and an orientation to induce a liquid crystal director adjacent the posts to adopt two different tilt angles in substantially the same azimuthal direction, as required by the claims of the present application. Bryan-Brown only teaches the use of a grating or grooves to impact alignment, whereas its pillars are for spacing only and impact no alignment properties whatsoever.

12. With respect to claim 7, the Action again incorrectly treats the surface alignment grating or grooves of Bryan-Brown as an array of posts. It then asserts that the passages at column 9, lines 14-16 and 54-58 anticipate claim 7 (and, by implication, claim 6, on which claim 7 is dependent). Claim 6 specifies that "at least part of a side wall of said posts is tilted at a tilt angle with respect to the normal to the plane of said first cell wall". Claim 7 recites a preferred range for the tilt angle of about 5 to 7°. The cited passages do not disclose any such tilting of a side wall of a post. They simply disclose that disclinations may be prevented by arranging the groove direction of the grating on one wall non-parallel to the rubbing alignment direction on the other cell wall. Example 3 of Bryan-Brown describes a grating on a first cell wall opposite a rubbed polyimide surface on a second cell wall. Furthermore, one skilled in the art would recognize that the polyimide rubbing direction on the second cell wall in Example 3 is in the plane of the second cell wall. This plane is parallel to the first cell wall having the grating. Example 3 also describes a well-known problem of having the rubbing direction itself parallel within these two planes to the groove direction, that is having the rubbing lines in the plane of the second cell wall be in the same direction as the grooves in the plane of the first cell wall. This arrangement may cause twist disclinations. Bryan-Brown provides two well-known solutions to this problem: 1) adding a cholesteric dopant and 2) arranging the groove directions non parallel to the rubbing alignment directions, eg about 5 degrees adjustment. One skilled in the art would know this second option to mean that the rubbing direction is offset by an angle of, for example, 5 degrees within the plane of the second cell wall so that the rubbing direction is not parallel to the groove direction. The rubbing direction remains in the plane of the second cell wall.

This is done to prevent twist disclinations. Accordingly, as discussed above, Bryan-Brown does not disclose or suggest bistable alignment posts let alone a side wall of such a post that is tilted at a tilt angle with respect to the normal to the plane of the first cell wall, as required by claims 6 and 7.

13. With respect to claim 10, the Action asserts that the passage at column 3, lines 46-49 of Bryan-Brown discloses posts arranged in a random or pseudorandom array. The passage does not relate to posts, but to an alignment grating, which is a one-dimensional array. Contrary to the Action's assertion, variation in the shape or profile of the grating does not make the *arrangement* of the array random or pseudorandom. Therefore, Bryan-Brown does not disclose or suggest a surface alignment comprising an array of posts or any surface alignment that is arranged in one of a random or pseudorandom *array*, as required by claim 10.

Jones *et al* (WO 99/34251)

14. Claim 2 is rejected on the ground that its subject matter is obvious over a combination of the teachings of Bryan-Brown and Jones. Claim 2 specifies the following:

said liquid crystal material has negative dielectric anisotropy; and

said second cell wall has a surface alignment which induces local homeotropic alignment of said liquid crystal director.

15. As I have explained in 6) to 12) above, I believe it is clear that Bryan-Brown does not anticipate claim 1. Bryan-Brown is therefore of even less relevance to claims dependent on claim 1 and of narrower scope. Additionally, the Action has misinterpreted the teachings of Jones, as I will discuss below.

16. The Action states that "...the homeotropic orientation is well described by Jones in page 7, lines 1-23." The Action is wrong. Jones does not disclose homeotropic orientation at the <u>second cell wall</u> in the cited passage. The cited passage relates to ways of making the orientation of the liquid crystal <u>at the grating surface</u> substantially perpendicular (ie, locally homeotropic).

17. To the contrary, what Jones actually teaches about alignment at the second cell wall ("the single alignment surface") is disclosed on page 7, lines 27-30. This passage says that "[t]he single alignment surface may be any monostable surface which is substantially planar homogeneous, or tilted homogeneous so that the surface induced pretilt is significantly less than the possible pretilts from the zenithal bistable surface, for example between 0.1° and 20° from the cell plane. Thus, Jones specifies that the surface of the second cell wall <u>must not be</u> homeotropic. It is therefore clear that Jones teaches away from the present invention.

18. The Action asserts that claims 25-27 are obvious over the teachings of Bryan-Brown because "Bryan-Brown discloses that the gratings may have any shape and may be embossed as posts so as to permit the liquid crystal molecules to adopt two different pretilt angles in the same azimuthal plane (col. 3, lines 30-63). I have already referred to this passage. The Action muddles the disclosure of Bryan-Brown in a way that totally distorts the actual disclosure. Contrary to what the Action asserts, the cited passage discloses alignment by means of a grating, not by an array of posts. Quite separately, the additional provision of optional "small pillars" is mentioned. These "small pillars" are not for aligning the liquid crystal, but are stated quite clearly to be "for assisting in correct spacing apart of the cell walls and also for a barrier to liquid crystal material flow when the cell is flexed". The Action then goes on to say "...it would have been obvious ... to produce a desired grating profile for the post which is cylindrical or has a cross section selected from square shape or an oval shape or a diamond shape..."Since a grating is not an array of posts, and posts do not have "a grating profile" this statement is clearly incorrect. Moreover, there is absolutely no disclosure or suggestion in Bryan-Brown of posts having any of the quoted shapes, nor is any reason given why it would be obvious to produce such shapes. Such a conclusion could only be reached with impermissible hindsight knowledge of the present invention.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed:.....S. Kitson.....

STEPHEN CHRISTOPHER KITSON

Dated:.....19th September 2003